

MONDAY

COLLOQUIUM

Quantum Geometry of Electrons in 2D Materials: Proposals of GQuES Spectroscopies and Anomalous Hall Transistor

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19 May 2025 (Monday) | 16:00 Hrs (Tea / Coffee 15:45 Hrs) | Venue: TIFRH Auditorium

We will first present an introduction to quantum geometry of electrons in periodic structures in terms of Berry phases and curvature. We show that the coupling of dynamical excitations like phonons with electrons can have nontrivial consequences to quantum geometry of electronic structure, which manifest as oscillations in the Berry curvature dipole and hence have observable nonlinear Hall signatures. Using these, we introduce a vibrational spectroscopy [1] based on Geometry of Quantum Electronic Structure (GQuES) making specific predictions for the transport and radiative GQuES spectra of 2D materials. We demonstrate that a quantum material like graphene can be used as a substrate in GQuES spectroscopic analysis of other materials with trivial quantum geometry, significantly expanding the domain of applications of quantum materials. Combining this with the idea of broken symmetries in 2D hetero-structures, we demonstrate emergence of nontrivial electric and Berry curvature dipoles in the heterostructure of graphene and monolayer of CrTe₂, and propose an Anomalous Hall Transistor [2] enabling electrically and magnetically readable memory.

References:

1. R Bhuvaneswari, Deshmukh M M and Waghmare U V, *Phys. Rev. B* 2024, **110**, 014305.
2. Menon Surabhi and Waghmare U V, *Nanoscale* 2025, **17**, 896.